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AN ESKER GROUP SOUTH OF DAYTON, OHIO.[1]

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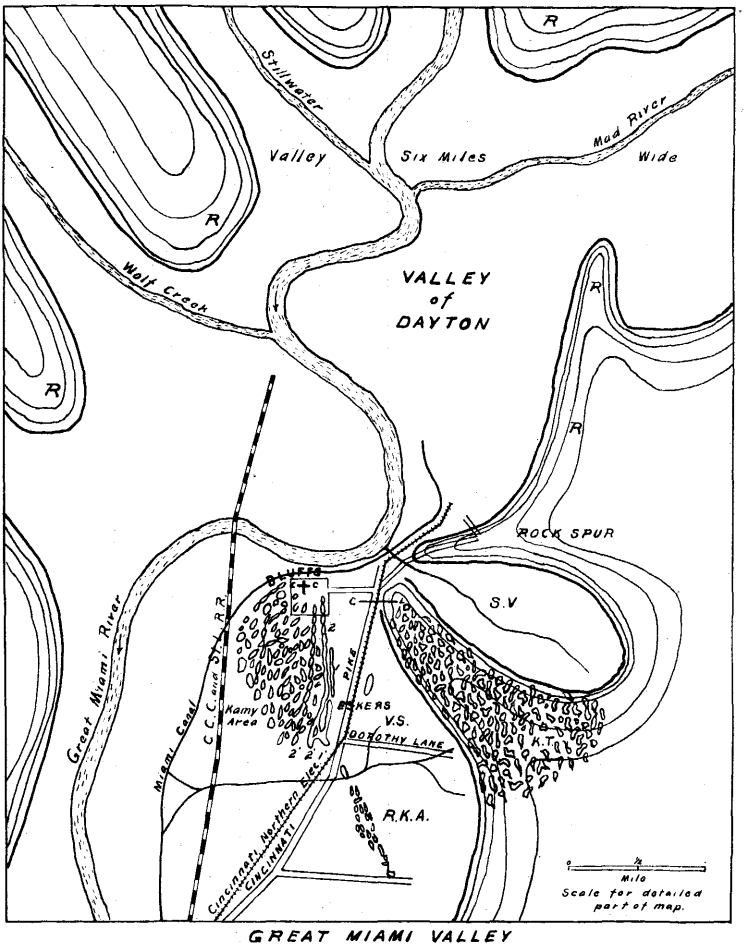
Contents.

Introduction. This paper has for its object the discussion of an esker group[2] south of Dayton, Ohio;[3] which group constitutes a part of the first or outer moraine of the Miami Lobe of the Late Wisconsin ice where it forms the east bluff of the Great Miami River south of Dayton.[4]

1. Given before the Ohio Academy of Science, Nov. 30, 1907, at Oxford, O., representing work performed under the direction of Professor Frank Carney as partial requirement for the Master's Degree.
2. F. G. Clapp, Jour. of Geol., Vol. XII, (1904), pp. 203–210.
3. The writer's attention was first called to the group the past year under the name "Morainic Ridges," by Professor W. B. Werthner, of Steele High School, located in the city mentioned. Professor Werthner stated that Professor August F. Foerste of the same school and himself had spent some time together in the study of this region, but that the field was still clear for investigation and publication. Professor Foerste later made practically the same statement. The writer is indebted to both of these gentlemen for their courtesy. He also wishes to thank his instructor Professor Carney, for going over the field with him and taking the several excellent photographs illustrating this article.
4. F. Leverett, Monograph XLI, U. S. Geol. Surv., (1902), p. 355.
   T. C. Chamberlin, 3rd Annual Report, U. S. Geol. Surv., (1881–82), p. 334.



GREAT MIAMI VALLEY

FIG. 1.

This figure shows in the lower part a map of the esker and kame region. The topographic features are drawn purely diagrammatic, being intended only to give a general view of the relationship of the valleys, esker and kame area to the valley walls.

Representations of Initial Letters: R—Rock (outcrops); S. V.—Small Valley; V. S.—Valley Segment; K. T.—Kamy Topography; R. K. A.—Ridged Kame Area; 1, 2—Eskers Nos. 1, 2; 1′, 2′—Knoll Endings of Eskers; C. C.—Calvary Cemetery; C. L.—Southern Corporation Line of City of Dayton.

General Discussion of Eskers. Much question and dispute has arisen in the past concerning the terminology[5] for certain ridge-like products of glaciation, but the designation "Esker" is generally applied by American Geologists to lines of debris presumably aggraded by streams between walls of ice. Though the theory of deposition in sub-glacial tunnels[6] holds the greatest credence today, the en-glacial and super-glacial or various combinations of the three theories have been offered as plausible explanations in specific instance.[7] For convenience this article assumes in the beginning that the Dayton ridges are eskers, and that they were formed in sub-glacial tunnels.

Preliminary Description of Region. (Fig. 1.) The northern end is known locally as "The Bluffs." These trend east-northeast to west-southwest about half a mile presenting an abrupt slope considerably over one hundred feet high toward the valley of Dayton to the north. The Miami canal runs along the slope not far from its bottom, and below this at the base of the Bluffs flows the Great Miami River. The topography of this and also of the western half of the area presents a beautiful study in kames; mounds and basins[8] are abundant. The mounds or knolls frequently show a tendency toward alignment producing ridges. The eskers indicated on the map constitute the eastern boundary of this kame area. They overlie their base like railway embankments crossing uneven topography.[9] From the region of the Bluffs they proceed southward about a mile ending bluntly on the Miami Valley. The crest-lines are sinuous in both vertical and horizontal directions, though the general course is in almost a straight line. The esker form is at times modified by knolls, rarely by distinct gaps. The crests are narrow and the sloping sides steep, apparently taking the angle of repose normal to the debris of which they are composed. Both the eskers and the kamy topography westward rest upon a base rising above the valley of the Miami. To the southeast, across the roadway from the southern ends of the eskers the kamy topography continues for about a mile. This topography shows a curious branching and anastomosing of ridges. Though at present suggestive of kames it is quite possible that it represents modified glacial phenomena of other than kame origin. A more elaborate study of this will be made in a future paper.

5. G. F. Wright, The Ice Age in North America, (1891), p. 296.
   G. H. Stone, Monograph XXXIV, U. S. Geol. Surv., (1899), pp. 35, 359.
   W. C. Morse, The Ohio Naturalist, Vol. VII, (1907), pp. 63–65.
6. Chamberlin & Salisbury, Geology, (1906), Vol. III, pp. 373–7.
7. W. M. Davis, Proc. Bos. Soc. Nat. Hist., Vol. XXV, (1892), pp. 477–99.
   J. B. Woodworth, Proc. Bos. Soc. Nat. Hist., Vol. XXVI, (1894), pp. 197–220.
   O. H. Hershey. Am. Geol., Vol. XIX, (1897), pp. 197–209, 237–253.
   W. O. Crosby, Am. Geol., Vol. XXX, (1902), pp. 1–39.
8. T. C. Chamberlin, loc. cit., p. 334.
9. Chamberlin & Salisbury, loc. cit., p. 375.

Bearing on Archaeology. There has been a tendency in the past to explain formations of the esker type as the work of Indians or Mound Builders,[10] an error not without justification. Evidence of design in the Dayton ridges is patent to the unitiated. They suggest an immense fortification composed of lines of earthworks; the knolls serving as lookout and signal stations, gaps for ingress and egress, and short connecting embankments as roadways from ridge to ridge. Several references are made in local histories[11] to the work of Mound Builders found in what is now Calvary Cemetery (C. C., Fig. 1). Of these the following quotation is the most comprehensive:—"South of Dayton on a hill one hundred and sixty feet high is a fort enclosing twenty-four acres. The gateway on the south is covered in the interior by a ditch twenty feet wide and seven hundred feet long. On the northern line of embankment is a small mound from the top of which a full view of the country for a long distance up and down the river may be obtained."[12] Other isolated portions are explained similarly by residents.

Such explanations are to be doubted as few if any more than the number of Indian relics normal to this section of Ohio are found. Even admitting the archaeologic suppositions, the accredited Indian work constitutes so little of the region studied, with but trifling interference to the general plan, that it may be disregarded. That no large portion can be of human construction is apparent not alone from the size of the formation, but from the evidence of assorted material in numerous cuts.

Topographic Relations. Eskers differ in their relations to the topography of the area on which they rest, but according to Chamberlin and Salisbury they were probably most frequently made by streams flowing about "parallel to the direction of the ice movement."[13] The same writers also suppose the most favorable position for their formation to be "near the edge of the ice during the time of its maximum extension or retreat."[14]

It is possible that the topography of the Dayton area offers the best explanation, on a sub-glacial hypothesis, for the origin of these local eskers. Dayton lies in a large valley (Fig. 1) formed by the junction of the Stillwater and Mad Rivers and Wolf Creek with the Great Miami River. The enclosing rock-bearing hills rise about 200 feet above the flood plain. The basin is filled with a varying depth of debris exceeding in places 200 feet.[15] The maximum width of the valley is about six miles. To the southward beyond the junctions the valley narrows to about

10. G. H. Stone, loc. cit., p. 35.
11. History of Montgomery County, Ohio, (1882), p. 216.
12. Quotation in "History of Dayton," (1889), p. 10, from J. P. McLean's work, "The Mound Builders."
13. loc. cit., p. 376.
14. Ibid, p. 374.
15. F. Leverett, loc. cit., p. 361.

one-third its greatest width. This narrowing is produced principally from the eastern side by a rock spur (Fig. 1), south of which the valley again widens but not to its former size. The last rock outcrop on this spur was found on its top and several hundred yards from the end. The Bluffs extend west-southwest from this spur, the two prominences being separated by a gap which permits the egress of drainage from a small valley (S. V., Fig. 1) connected with the spur. The eskers and kame area spreading southward from the Bluffs cut off a small segment of the Great Miami Valley (V. S., Fig. 1) lying south of the spur.

Theories of Origin. In diagrammatic view (Fig. 1) the valley of Dayton appears as an oblong basin with wide gaps for the entrance of the Miami River and tributaries, and one for the departure of the combined drainage. This great basin may have exerted an important influence on the waning glacial ice in controlling its movement in this area, and also in concentrating drainage that became sub-glacial.[16] That this basin and its tributaries do represent glacial drainage lines[17] is proved by the great depth and character of the debris filling. The over-riding ice would drop into the Dayton valley as in a pocket. This in the stagnant ice stages would accentuate its immobility thereby conducing to esker-forming conditions. The concentrated drainage would seek the point of easiest egress which would probably be somewhere in the gap to the south. While under great head, as doubtless the drainage would be at times of most active ice-melting, topography might to some extent be disregarded. This could explain the appearance of the ridges on the eastern side of the valley gap (possibly even superimposed over a continuation of the rock spur) rather than in the center.[18]

The close association of the eskers with kame deposits suggests that the latter were formed during the retreat of the ice after the eskers had been built in sub-glacial stream tunnels. This kame area doubtless spread originally further across the valley but has in part been removed by the meanderings of the Miami River. The abrupt face presented to the north by the Bluffs may also have the same explanation; it has already been noted that this river flows at the present time along their base. If this explanation is correct, the kame and esker topography may formerly have extended an indefinite distance northward into the Dayton Valley.

Detailed Description of Eskers. It is unsafe to number these ridges as marking separate and distinct lines of drainage, but for convenience this method will be adopted. The easternmost will

16. I. C. Russell, Jour. of Geol., Vol. III, (1895), p. 827.
O. H. Hershey, loc. cit., p. 240.
17. F. Leverett, loc. cit., Pl. II.
18. Chamberlin & Salisbury, loc. cit., p. 375.

be designated No. 1 and the next west No. 2. Other lines may exist buried beneath and masked by the kame deposits.

No. 1 (Figs. 1, 2.) This may branch from No. 2. As an independent ridge it proceeds from its head (about a quarter of a mile below Calvary Cemetery) southward and almost parallel with the Cincinnati Pike to a point almost opposite Dorothy Lane (Fig. 1) where it ends in a cut. The upper end of this esker though distinctly ridged is not as typically esker-like as the lower end. Intersections between No. 1 and No. 2 occur near their southern terminals. These intersections at one point form a "Y", the base of which starts from No. 1, the branches leading to No. 2. At all the intersections, four in number, the ridges

Fig. 2. View looking north on esker No. 1.

rise, forming knoll-like prominences. Small boulders about the size of cobbles are abundant on the surface. These are largely of local limestone of the same formation (Cincinnati) as that seen in the rock spur before mentioned. The exposed cut at the road shows principally coarse gravel mingled with sand. Some of this gravel has been cemented together into a form of conglomerate by the action of carbonated water.[19] Several feet of till containing a large percentage of small boulders overlies the gravel at this point. This exposed section at the time of the writer's first visit revealed the anticlinal stratification frequently mentioned in offering sub-glacial theories of origin. This may possibly be explained, however, by slumping of the material after

19. E. Orton, Geol. Surv., of O., (1869), p. 146.

the withdrawal of the ice. This cut has been extensively used by the Cincinnati Northern Electric, which runs alongside, in securing ballast for its new roadway.

No. 2. (Figs. 1, 3, 4.) This starts just within Calvary Cemetery. A short longitudinal cut has been made on the west side of this end, furnishing the gravel supply for the cemetery. From an abrupt rise it proceeds southward, coming alongside of No. 1, and following almost parallel. To the south it branches and ends bluntly on the Miami Valley in two prominent knolls aligned with the cut of No. 1 (Figs. 1, 6). Water is imponded at several points between No. 1 and No. 2. This ridge is separated the greater part of its length from the kamy area to the west by a distinct and deep trough.

Fig. 3 (*F. Carney*). View looking north on esker No. 2. A sharp turn and steep rise shows in background.

Kamy Area to the West of Eskers (Figs. 1, 5.) The kames here show a tendency toward alignment in short ridges. Sometimes they appear to radiate from a common center. Artificial cuts facing the valley show prevailingly fine material indicating by the stratification a very active play of waters.

Studies.

Proximity of Eskers. The distance between the two eskers is always slight. The surface outline of this distance is usually similar to a parabola shaped trough of such a size that if one of the adjoining ridges were inverted it would approximately fit the trough. The drainage from the troughs is principally through the soil.

Height of Eskers. The variation in altitude of the crest-lines and of the troughs gives varying heights at different points. No. 2 by aneroid measurement varies from 35— to 95+ feet in height. No. 1, if measured, doubtless would give similar results.

Reticulation. The two eskers show several connecting branches. This implies a union between the lines of drainage some time during their existence. These connecting branches are so depressed in parts that tracing is difficult. Such a condition would be natural as the cross drainage would normally be so sluggish that the tunnel carrying it would probably never attain a large size. It is a question whether the two eskers represent branches from one line of drainage or are entirely independent. They may even represent a shifting of drainage lines. The lower end of No. 1 suggests by its position (Fig. 1) that it may be a branch from No. 2, rather than a continuation from the head end of No. 1, as we have described it.

Fig. 4 (*F. Carney*). Camera reversed from fig. 3, and view taken looking south on same esker.

Knolls. Hummocks are frequent. Generally they mark the southern termini and ridge junctions. At its head end No. 2 is composed of a series of four joined together. Many theories[20] are given for the origin of such swellings. In connection with knolls other modifications of the esker type may be noted. Several buttress-like deposits were found lying against the bases of the eskers; sometimes also a fan-like spreading of debris from a similar position was observed. These irregularities probably mark the entrance to the major line of small tributary streams, or as an alternative, the opposite condition, leakage from the major lines. The knolls at the head of No. 2 are more suggestive of tributaries than of kames.

The knoll-endings (Figs. 1, 6) on the Miami Valley suggest by their alignment that they have been cut off at this point by the Miami River. Though this stream here turns to the westward, the even floor of the valley is evidence that it formerly turned

20. J. B. Woodworth, loc. cit., pp. 202, 203.

eastward. The fanning of the knoll-endings into the valley where they meet in an even slope is doubtless the result of slumping. Davis[21] gives a clear exposition of conditions when bodies of water are dammed by the ice-front, with the consequent phenomena of sand plains built up by esker streams. The Dayton area, however, shows no evidence of favorable conditions for the holding of ice-front waters, drainage having a perfectly free course toward the south. Streams emerging from the ice would spread out and quickly drain away. In this particular area such an outwash plain if formed would have been destroyed long ago by the erratic wanderings of the Miami.

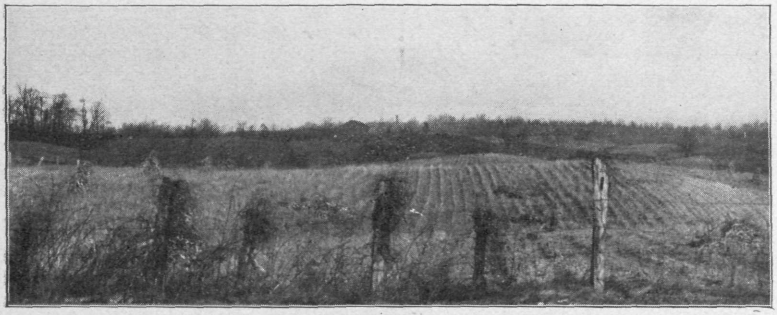


Fig. 5 (*F. Carney*). Kame area immediately west of esker No. 2. Camera facing north. Barn rests on a long ridge of kames.

Altitude of These Deposits. The elevation of the area above the valley is partly due to the base upon which it rests. This is shown particularly in the kame region, the inside slopes of which are much shorter than the slopes facing the valley, a condition explainable by slumping within the area and erosion around it by the Miami as before stated.

In this connection it may be suggested that possibly gradation has greatly modified the original eskers. At the time of ice-withdrawal these forms, particularly if sub-glacial in genesis, must have been left with little or no vegetative protection. It cannot be determined how long a time was required before plant life secured a good foot-hold, but it is reasonable to suppose that the interval was sufficient to permit considerable weathering even on such narrow forms as eskers. With the eskers in question is it not probable that after the constituting material had assumed its natural angle of repose they may have been considerably lowered by gradational processes? Such processes would also reduce the effect of height by partially filling the trough.

21. W. M. Davis, Bull. Geol. Soc. Am., Vol. I, (1890), pp. 195–203.

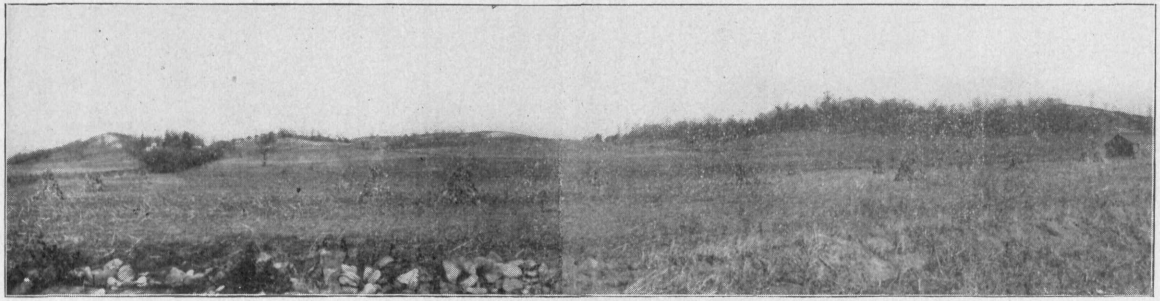


Fig. 6 (*F. Carney*). View looking north from Miami Valley, showing southern termini of eskers. Knoll to right belongs to esker No. 1. Two knolls next west apparently belong to esker No. 2. Westernmost knoll is a part of the kame area.

Composition of Eskers. A layer of bouldery till spreads over the group. This varies in thickness sometimes being five or six feet deep. Such a deposit, of course, supports the theory of sub-glacial origin, representing as it does the melting of a body of debris-laden ice above. The gravel beneath this till in the eskers is composed of a large percentage of Ohio limestone intermingled with foreign rock. Though mixed with sand it is practically free from clayey material. Cobbles of flat angular limestone are abundant on the surface. At times these cobbles intermingled with foreign boulders of similar size literally pave the surface, a result possibly of concentration through the removal of fine material by washing. Big granite boulders are rare.

Rock Weathering. The surface boulders show varying degrees of weathering. The limestone, not being very resistant to water action, particularly shows age. Granites sometimes appear fresh at other times are decidedly pitted. If this irregularity is not due to their chemical composition, the inference would be that boulders representing several different glacial periods have been mingled. In a stream-cut south of the eskers many greenstones appear. These are described by Chamberlin and Salisbury[22] as particularly abundant in sub-Aftonian drift. It may be that in these conditions evidence may be found that this area represents pre-Wisconsin glaciation and later reworking during the Wisconsin period. Such a theory would not necessarily oppose anything that has already been conjectured with regard to the history of the region.

Crest-Lines. While the crest-lines are sometimes quite hummocky, the typical esker form is found in all its beauty. Straight, even-sloped sections several rods in length may be found, but the course usually is serpentine, the crest-line waving up and down and from one side to the other of a straight line. Several gaps occur, some perhaps artificial; others may be due to constrictions in the ice tunnel or various local modifying conditions. Though the general course of these eskers is straighter than in the usual type, this offers nothing inconsistent with the sub-glacial theory of origin; in fact it seems reasonable to suppose that confined streams of sufficient size to build up immense ridges of coarse material would naturally hold to a comparatively straight course.

Economic Importance.

These ridges have great economic value. The supply of gravel and sand is practically inexhaustible. The C. C. C. & St. L. steam R. R., and the Cincinnati Northern Electric run conveniently near and have made extensive cuts in securing ballast. The position of the ridges overlying the valley reduces the ex-

22. loc. cit., p. 384.

pense of cutting to a minimum. Tracks are run alongside and big steam scoops gather up the gravel and throw it into cars. In addition to that used by the railroads many loads are taken away in wagons. Formerly considerable sand and gravel was taken from the Bluffs by boats plying on the canal; this method of transportation is no longer operative, partly because of the decreased depth of this waterway. The group occupies something less than a square mile of surface. But little of this acreage is devoted to farming, most of it serving for pasture. There are several very desirable locations for summer homes and also opportunities for parking.

Area to the East.

The easternmost esker and the ridged relief starting on the opposite side of the roadway at its southern end block off a portion of the valley apparently belonging at one time to the Great Miami, though the level of this valley is considerably higher than the present flood plain of the Miami Valley.

Conclusion and Summary.

Eskers of Ohio have not been studied so exhaustively as those of other parts of the country, particularly of New England. Leverett, however, mentions eleven in this state, according to the tabulation by Morse[23] in his article on the "Columbus Esker."

In describing this area and in drawing inferences the writer has endeavored to be exact and not dogmatic. Some slight errors may have been made in data; theories in any case are uncertain. It may not be possible to work out with assurance the history of the group. So many factors may have operated together or against each other that the result would appear to be without "rhyme or reason" and too complicated for unraveling. From the present day evidence, however, the following conclusions are reached with some confidence:

1. These eskers conform in details to the type generally conceded to be of sub-glacial origin.
2. Their location was largely dependent on topography, lying as they do in a position favoring active sub-glacial drainage.
3. The heavy stratified glacial deposits other than eskers also indicate an activity of drainage beneath the ice or from its front.
4. The varying texture of the boulders suggests a reworking of old glacial debris by the last ice-sheet.
5. The inexhaustible supply of gravel and sand offered, together with convenient location and easy access give the area considerable economic value.

23. loc. cit., p. 66.